

## CS202 HOMEWORK#4

### 1. Questions

#### a) Insertion & deletion in an AVL Tree

insert 50-> 50

insert 70-> 50  
/

insert 90 -> 70  
/ \

50 90

insert 115 -> 70  
/ \

50 90  
115

insert 95 -> 70  
/ \

50 95  
90 115

insert 100 -> 95  
/ \

70 115  
50 90 100

insert 80 -> 95  
/ \

70 115  
/ \ /

50 90 100  
/

80

insert 125 -> 95  
/ \

70 115  
/ \ / \

50 90 100 125  
/

80

insert 105 -> 95  
/ \

70 115  
/ \ / \

50 90 100 125  
/ \

80 105

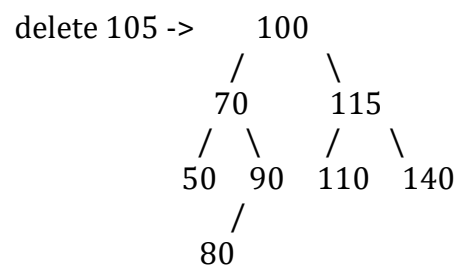
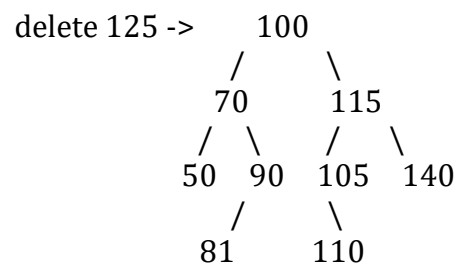
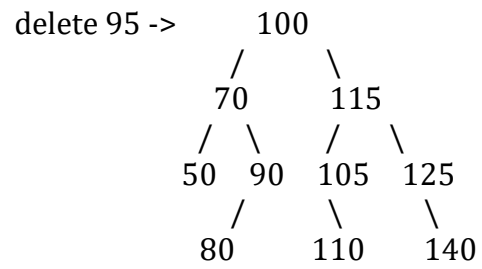
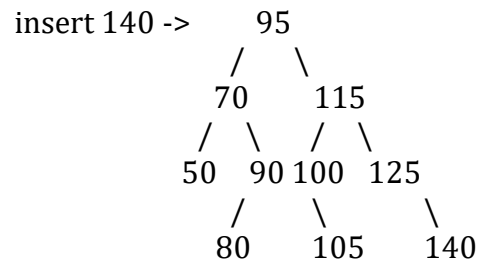
insert 110 -> 95  
/ \

70 115  
/ \ / \

50 90 105 125  
/ \ \

80 100 110

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## b) Insertion & deletion in a 2-3 Tree

insert 50-> 50

insert 70-> 50-70

insert 90 ->

```
      70
     /  \
    50   90
```

insert 115 ->

```
      70
     /  \
    50  90-115
```

insert 95 ->

```
      70-95
     /  |  \
    50  90 115
```

insert 100 ->

```
      70-95
     /  |  \
    50  90 100-115
```

insert 80 ->

```
      70-95
     /  |  \
    50  80-90 100-115
```

insert 125 ->

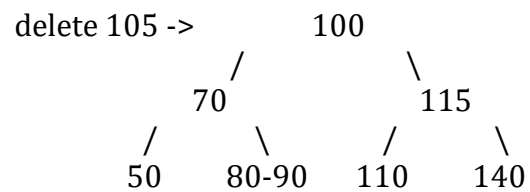
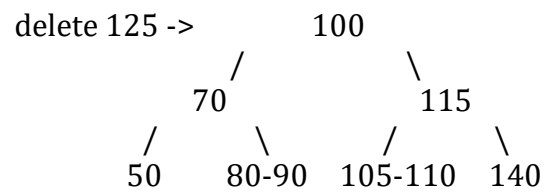
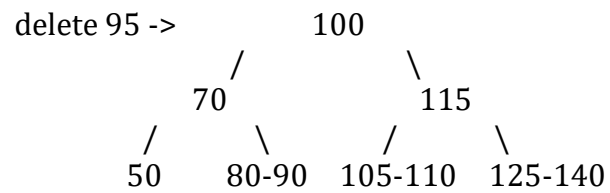
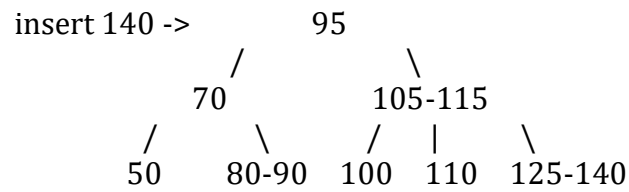
```
          95
        /   \
       70    115
      /  \  /  \
     50  80-90 100 125
```

insert 105 ->

```
          95
        /   \
       70    115
      /  \  /  \
     50  80-90 100-105 125
```

insert 110 ->

```
          95
        /   \
       70    105-115
      /  \  /  |  \
     50  80-90 100 110 125
```



### c) Insertion & deletion in a 2-3-4 Tree

insert 50-> 50

insert 70-> 50-70

insert 90 -> 50-70-90

insert 115 ->

```
graph TD
    70 --- 50
    70 --- 90_115[90-115]
```

insert 95 ->

```
graph TD
    70 --- 50
    70 --- 90_95_115[90-95-115]
```

insert 100 ->

```
      70-95
     /  |  \
    50  90 100-115
```

insert 80 ->

```
      70-95
     /  |  \
    50 80-90 100-115
```

insert 125 ->

```
      70-95
     /  |  \
    50 80-90 100-115-125
```

insert 105 ->

```
      _ 70-95-115 _
     /  /  \  \
    50 80-90 100-105 125
```

insert 110 ->

```
          95
         /  \
        70  115 _
       /  \  /  \
      50 80-90 100-105-110 125
```

insert 140 ->

```
          95
         /  \
        70  115 _
       /  \  /  \
      50 80-90 100-105-110 125-140
```

delete 95 ->

```
          100
         /  \
        70  115
       /  \  /  \
      50 80-90 105-110 125-140
```

delete 125 ->

```
          100
         /  \
        70  115
       /  \  /  \
      50 80-90 105-110 140
```

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